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ABSTRACT

The lower level of participation of females in computer science courses is a continuing concern for educators. A number of different reasons for this lack of participation have been put forward, including differences in attitudes, bias, role models, differential treatment by classmates and teachers, patterns of computer use, availability of computers and their associated subject areas. This series of studies, conducted over a three year period, examines potential factors affecting computer course participation by males and females in middle and high school grades. Differences in role models, attitudes, interest and computer use between gender as well as within gender were found to exist which may contribute to a continuing stereotype of computers as a male domain. (Author)

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Gender Differences in the Attitude, Interest and Participation of Secondary Students in Computer Use

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Abstract

The lower level of participation of females in computer science courses is a continuing concern for educators. A number of different reasons for this lack of participation have been put forward including differences in attitudes, bias, role models, differential treatment by classmates and teachers, patterns of computer use, availability of computers and their associated subjects areas. This series of studies, conducted over a three year period, examines potential factors effecting computer course particiaption by males and females in middle and high school grades. Differences in role models, attitudes, interest and computer use between gender as well as within gender were found to exist which may contribute to a continuing stereotype of computers as a male domain.

INTRODUCTION

As computers become increasingly accepted in schools,many people are concerned that gender equity is being ignored. Computer learning opportunities are less common among females (Damarin, 1989; Krendl, Broihier and Fleetwood, 1989; Linn,1985a, 1985b). This problem seems to stem from the already well-defined pattern of inequality, which exists throughout our school curricula and society in general. Indeed, computer study may be exacerbating this situation by reinforcing existing gender inequities rather than encouraging educational equity (Schubert, 1986).

This problem of inequity in computer studies (i.e.unequal access to computer resources by females) has several serious implications for the future. Anderson et al. (1984) write:

> Educational computer inequity threatens to separate groups and communities by giving some people more effective tools for living in the age of computer information systems (p.10).

This will leave an increasingly difficult problem to address as computers become more integrated into our lives.

Gender related differences among students today in computer education are likely to result in social,cultural, political, economic and educational gender discrepancy in the future (Damarin, 1989; Krendl et al.,1989; Martin and Hearne, 1989; Sanders, 1984). As students differentiate among themselves on the basis of gender, perceived differences may result in actual differences in performance and acceptance of technology.

In many elementary and middle schools, students' participation in computer classes is compulsory, and thus, every student in those schools should have equal opportunities to learn about computers. However, a number of recent studies have indicated that most of the students working with computers at the secondary school level are male, and as age increases, female enrollment in computer classes decreases. For instance, in a study of Princeton High School students, it was found that 60%of male students, and only 8% of female students used school computers voluntarily before, during, and/or after classes (Sanders, 1984). Also, in a study of freshman students from an introductory psychology class at a midwestern state university, Dambrot et al. (1985) found that female students showed more negative attitudes toward computers and scored lower in computer aptitude tests than male students. On the basis of a three-year longitudinal study of secondary school students, Krendl et al. (1989) found that female

students are less interested in computers and have less self-confidence in their computer related knowledge and skills than male students, even when both female and male students had similar experiences. Furthermore, according to McCain's study (1983), female students have a tendency to take general introductory computer courses rather than more advanced courses. Swadener and Jarrett's study (1986)with 256 students from grades four through eight has demonstrated gender differences in terms of students' computer use and preference. Levin and Gordon (1989) surveyed 222 students in grades 8 through 10 in a Tel Aviv high school, and found that boys have significantly more positive attitude towards computers and demonstrated more gender related stereotyped views on computers.

Other studies, however, have found sex not to be significantly related to students' computing abilities and their attitudes toward computers. For example, Loyd and Gressard (1984) surveyed 354 high school and college students concerning their attitudes toward computers. They found no evidence to indicate any difference between males and females in terms of computer anxiety, computer confidence, and computer liking. Further, Linn (1985a)and Mandinach and Fisher (1985) found that females and males performed similarly once they enrolled in computer programming courses.

There have been mixed opinions and research findings concerning gender equity in computer classes in secondary schools. There may be differences between school districts in gender equity and the way in which it is resolved. The ratio of males and females may be more apparent in the high level computer classes than in the low level computer classes. Also, gender related differences in computer learning seem to be developed as students get older (Loyd, and Glessard, 1984; Swadener and Jarrett, 1986; Swadener and Hannafin, 1987).

Further, where gender related differences in secondary schools can be found, the factors which contribute to the problem are not yet fully

understood. In attempting to explore gender related differences in learning computers, researchers and theorists have discussed possible factors that may create and reinforce the differences, such as a limited number of computers at school, the view of computers as math- or science-related, male-oriented content features of software,social expectations, familial influence, peer pressure, career plans and school policies.

One of the factors related to female students' less access to computers and negative attitudes toward computers is the way in which the computer learning environment is organzied. Where there are only a few number of computers and a large number of students must share the computers (DuBois and Schubert, 1986; Lipinski et al., 1986; Martin and Hearne, 1989; Schubert, 1986; Watt, 1983), females may be differentially effected. When demand higher than the number of computers available, the more aggressive ones students can use computers, and thus girls are more likely to be reluctant to insist on using computers than boys. Also, it is argued that gender related differences emerge in relation to the way computers are used and learning settings are organized (Hawkins, 1985).

Computer education is often identified with math and science education. While many teachers and students seem to perceive computers as being related to mathematics and sciences, such perception has several serious implications for female students because math and science are often perceived as male-type subjects (Fennema,1984). When computer learning is associated with math and sciences, this can lead most female students to lose interest in computers and to limit their access to computers (Campbell, 1984; Collis, 1987; Damarin, 1989;Hawkins, 1985, 1987; Kiesler et al., 1983; Linn, 1985b;Martin and Hearne, 1989; Munger and Loyd, 1989). However, in most schools, computers are integrated into the math and science curriculum, and frequently computer teachers are math and science teachers (Campbell, 1984;Damarin, 1989; Kiesler et al., 1983). Further, some

schools require students to take math courses before they allow them to take computer courses (Kiesler et al.,1983; Lockhead, 1985).

It has also been generally acknowledged that most computer software seems to show male oriented images which are very competitive, warlike and aggressive. Most educational computer software, especially educational game, stresses competition and aggressiveness, and is often filled with warlike situations. Because females have been socialized to be less competitive than males, these violent themes do not appeal to female students, and tend to lead them to lose their interest in learning about computers (Ellis, 1990; Damarin, 1989; Hess and Miura, 1985; Lepper and Malone, 1983; Linn, 1985b; Lockheed, 1985; Martin and Hearne, 1989; Rosenthal and Demetrulias, 1988; Schubert,1986; Sheingold, Kane and Endreweit, 1983; Ware and Stuck, 1985).

Parents' stereotyped expectation about children seem one of the factors effecting gender differences in computer learning and use. Parents usually see technical careers only for their sons, not for their daughters. Because of such stereotypes of what is appropriate for girls or boys, many parents seem to encourage boys to be enrolled in extra-curricular activities such as computer camps and clubs more often than girls (Miura and Hess, 1983; Wilder et al., 1985). Therefore, male students are more likely to have computer experiences than female students. Further, experiences of using computers are closely related to positive attitudes towards computers.

The stereotype of computer education as male dominated is often due to the ways in which microcomputers are introduced, adopted and used (Campbell, 1984; Martin and Hearne, 1989). The fact that most computer teachers and users are male and thus females have few role models in computer-related fields may explain gender related differences in computer learning environments. The identification with role models may also extend to parents and friends. Students may make decisions about

participation based upon the significant other individuals in their lives. With middle and high school aged students, friends, siblings and parents may be as influential as teacher role models.

Peer pressure may be considered one of possible factors interfering with gender equity in computer learning. Female students often feel conflict between their desire to socialize with friends and their willingness to learn about computers (Schubert, 1986). Since adolescents are especially sensitive to their peers' perception, females at that age have a psychological barrier withholding them from involving in what they perceive as a male-dominated field (Martin and Hearne, 1989).

PURPOSE

This research consisting of three separate studies has been conducted over a three-year period. The purpose of the present studies was to investigate the existence of gender related differences among secondary students in computer use and possible factors affecting such differences. The series of studies has been conducted with students enrolled in secondary schools in a medium-size metropolitan school district in the Midwest.

The common elements of all these studies consisted of the questions on students' attitudes toward computers, experience with computers, future plans concerning computer related careers and role models. The first study was conducted with high school students enrolled in elective computer courses. It focused on three key areas of concern. First, it examined to what extent if any, there existed gender related differences in actual enrollment figures. Second, it also sought to determine whether gender related differences were in any way related to computer course levels. Third, it

explored possible factors influencing the differences.

The second study was conducted to extend the findings of the first study. In the second study, the high school students who were not enrolled in elective computer courses as well as those who were enrolled in the courses were surveyed. The purpose of the study was to examine differences between students who have taken at least one elective computer course and those who have not taken any, and between students who intend to take a high school computer course and those who do not in relation to their gender. In addition, the researchers explored how students who have taken at least one elective computer course felt about the overall course, and peers and teachers in the course.

The third survey study was administered for the further exploration of factors affecting gender differences in computer use at an earlier age. In the study, students in a middle school were surveyed. Additional information was gathered on students' experiences with extracurricular activities and their prior experiences with computers in terms of their feeling about the overall courses in which they used computers, interaction with peers and teachers in the courses, the availability of computers at school, the content of software used in the courses, and the subject areas in which they have used computers or in which they wish to use computers.

STUDY 1

Objectives

The following research questions were examined:

1) Is there a gender related difference in enrollment in computer courses?

2) Does the difference in enrollment change as the level of computer class increases?

3) Do gender and course level related differences exist among students enrolled in computer classes in terms of the following criteria:

general attitudes toward computers
confidence with computers
perceived usefulness of computers
gender related bias toward computer use
experience with computers
plans for further computer study or professional work
role models

Method

A survey was administered to the total population of students enrolled in high school elective computer courses in the school district during the fall of 1987. There were a total number of 166 respondents, 104 of which were male and 62 of which were females. Data were also collected from four high schools in the district concerning male and female enrollment numbers for all beginning and intermediate computer classes.

A survey was developed to assess students' attitudes towards computer use. The first part of the survey was adapted from a computer attitude scale used in a published study (Swadener and Hannafin, 1987). It consisted of seventeen questions utilizing a five item Likert scale ranging from strongly disagree to strongly agree and posed questions concerning general attitudes toward computers, self confidence, computer utility, and sex bias. The second part of the survey consisted of questions relating to total time spent with computers, plans for future computer study and professional work, and male and female role models who use computers, .

The data on enrollment figures were analyzed using the Chi-square test of population to determine any differences between males and females, and introductory and intermediate level courses. The data concerning the other variables addressed by the survey were analyzed according to gender and course level differences by comparing their means and performing an analysis of variance (one way ANOVA).

Results

The differences between males and females in beginning and intermediate class were most apparent in the role models available to the students, sex bias and their view of gender differences. The general attitude of the students, perceived usefulness and self confidence in use of computers did not produce significant differences in this study. The tables and graphs illustrating the differences that were found are presented in Appendix 1.

The difference in the numbers of computer students is illustrated by Graph 1. The number of females is less for beginning computer courses with the largest difference appearing in the intermediate courses. Anecdotal information from computer teachers indicates that these differences are historical and that the number of beginning class females is usually lower.

The role model data (Graphs and Tables 2-4) show that female students in computer classes tend to have a larger number of role models than the males in these classes. This apparent difference is larger for females with female role models than females with male role models.

The attitudes of computer students about males and females in relation to computers is given in sex bias and perceived differences (Graphs and Tables 5-6). The stereotypical sex bias of males and computers is higher for

males than for females with a slight increase from first to second courses. The perception of computers as a male domain is high for beginning females and nonexistent for intermediate females while the same perception increased for males (some student wrote the the low participation of females in intermediate courses is proof of a difference).

Discussion

Some of the more popular beliefs about differences between males and females seem not to be present in this study. The attitudes of females appear to be just as positive toward computers as that of the males in the study. The difference in the sex bias and perceived differences between male and female abilities appear to be related to a readily observable drop in female enrollment in intermediate computer science classes. The striking difference in the total number of role models and female role models for female students in intermediate computer science courses could have the greatest practical significance. The positive encouragement of parents and friends may make the difference between contribution in computer study for females.

STUDY 2

Objectives

The research questions that guided this follow-up study were:

1) Do differences exist, within male and female groups, between students who have taken at least one elective computer science course and those who have not taken any computer course, and between students who

intend to take an elective computer course and those who do not in terms of the following criteria:

general attitudes toward computers
confidence with computers
perceived usefulness of computers
gender related bias toward computer use
experience with computers
plans for further computer study or professional work
role models

2) Do differences exist among the students who have taken at least one elective computer course in relation to gender within male and female groups, between the students who intend to take an elective computer science course and those who do not in terms of the following criteria:

feeling toward the course
interaction with peers in the course
interaction with teachers in the course

Method

This study was conducted in the fall of 1988. The factors that contribute to low enrollment of females in computer science may be evident in students that do not take such courses. Thus, students who were not enrolled in computer courses as well as the students enrolled in computer courses were surveyed.

There were a total number of 328 respondents, 195 of which were male and 133 of which were females. Data were collected from the three high schools in the school district. All the students enrolled in computer courses in the three schools were surveyed. Non-computer science student results were obtained by randomly selecting homerooms and having students in the selected homerooms answer the survey. Those who were enrolled both

in computer courses and in the selected homerooms did not complete the survey a second time.

The survey developed for the first study was added to and modified for the second study. In part two of the original survey, the following questions were added: whether students have taken any high school elective computer courses or not; how many elective computer courses they have taken in high schools; if they have taken any, how they felt about the overall course ,and peers and teachers in the course; and whether they plan to take a computer course later in high schools. A role model check list matrix was developed to replace open-ended questions concerning use of computers by acquaintances in the workplace, home and school. Space was provided for comments about gender related attitudes, computer learning and the importance about computers on the page three as well as for additional overall comments on the page four.

The data concerning students' future plans and attitudes were analyzed using the Mann-Whitney U test to determine any difference between the students who have taken at least one elective high school computer course and those who have not taken any elective computer course in high school. The same test was also used to determine any difference between the students who intend to take a computer course in high school and those who do not intend to take it in relation to their future plans, attitudes and (if they have taken any computer course) their overall feeling toward the course and interaction with peers and teachers in the course.

The data on total time spent with computers and role models were analyzed by performing the T-test to explore any existence of difference between the students who have taken any elective computer course and those who have not, and between those who intend to take a computer course in high school and those who do not intend to take a course.

Results

Differences between the students who have taken a computer course and those who have not, and between those who intend to take a high school computer course and those who do not were significant for both males and females (Appendix 2).

Concerning the attitudes, perceived usefulness of computers, general attitudes toward computers and confidence with computers were all significantly more positive for students who have taken at least one elective computer science course and those who intend to take another course across gender (Table 3). However, for students' gender related bias toward computer use, differences were apparent only for males.

Concerning the future plans for taking a computer course after high school and for having a computer related job, computer course students and those who expressed interest in another computer course showed more positive opinions both for male and female students (Table 2). In contrast, significant differences were found for students' future plans to major in computer science in college only between those who intend to take a computer course and those who do not.

The weekly total time of computer use for computer students was substantially different than for those who have not taken a computer course (Table 5). The difference between intent to take a course in hours of computer use was only significant for males.

The role models for students both intending to take a computer course and actual participants showed significant differences with respect mostly to male role models (Table 1). These differences were also more prevalent in the school than in the home or workplace (Graphs 1-2). The number of school friends and male teachers who use computers were significantly different between students who have taken a computer course and those

who have not across gender. The same difference was found only for females between those who want to take another computer course and those who do not.

Among the students who have taken at least one high school computer science course, while their feeling toward interaction with peers and teachers showed no significant difference between those who intend to take a computer course and those who do not across gender, overall feeling toward the course itself turned out to be significantly different only for females (Table 4).

Students' anecdotal answers to open-ended questions are given in Appendix 5. These responses are included to give the reader a better feel for the way in which students view their current or potential participation in computer courses. For the most part they seem illustrative of the significant findings in this study and do not hold any surprises.

Discussion

The overall pattern of computer course participation and intent to participate seems to be consistent with other findings. The difference in attitudes, interest and participation in computer use seems to be fairly consistent and predictable for both males and females. In a few instances do males and females differ on some points. This is perhaps an important consideration because of the generally accepted but not supported claim that some make about differences between males and females.

Students who have computer-related plans for future, often use computers and/or perceive computers in a positive way are more likely to also be interested in taking a(another) computer course. Especially, students that perceive computers to be useful are more likely to have been enrolled

in a computer course. The general attitude toward computers is also more positive for computer students. Self confidence is higher for computer students as well. This is supported in the significant difference in self confidence, perceived usefulness of computers and general attitude scales. The only difference between males and females in attitudes surfaced in the area of sex bias. Males who have participated in a computer class are significantly more biased than those who have not participated. Females on the other hand do not appear to differ greatly in sex bias regardless of course participation. The lower sex bias of males who have taken a computer course is still not as low as females who either have or have not taken a course.

The number of role models for males and females, for the most part, is similar for both genders with a couple of notable exceptions. The data for work role models shows little relationship to participation in computer courses or the intent to participate. The presence of friends who are computer users at home appears to have a differential effect on males. Those with male friends who use computers at home are more likely to be computer course participants and be interested in taking a course. A comparable relationship does not exist for females. Concerning school role models, it seems that the school is important in making courses related decisions. The more consistent finding is the relationship between computer using friends and male teachers at school and course participation. The male teacher relationship to participation may be explained by the high number of male teachers in computer courses. While it appears that friends in school are a greater influence for females than males in making computer related decisions, with low initial female participation in computer class, this trend may be slow to turn around.

Students who have or are taking computer classes when reporting their peer and teacher interactions do not indicate any relation to future course

participation. This may indicate that other factors are greater determinants in their decision than the apparent helpfulness of others in class. Their general like or dislike of the computer class was related to this decision. Possible reasons for this feeling were not included in this survey.

STUDY 3

Objectives

The following research questions were raised to serve the purpose of the study:

1) Do differences exist among students based on gender, grade level and intent to take a computer course in terms of the following criteria:

general attitudes toward computers
confidence with computers
perceived usefulness of computers
gender related bias toward computer use
experience with computers
use of computers as extracurricular activities
plans for further computer study or professional work
role models
perception of difficulty and importance of computer use

2) Concerning students' previous work with computers in classes, do differences exist among students based on gender, grade level and intent to take a computer course in terms of the following criteria:

feeling toward the computer classes
interaction with peers in the classes
interaction with teachers in the classes
availability of computers at school

content of software used in the classes
perception of friends' reactions to learning about computers
subject areas in which they used computers
subject areas in which they wish to use computers

Method

The differences and similarities between males and females discovered in the previous studies with high school students provide some ideas on factors causing unequal participation in computer science classes by males and females. Further investigation of the information on students' interest in using computers and attitudes toward computer learning at an earlier age would be valuable in providing additional insight into the possible factors influencing females' low rate of computer course selection.

Thus, this survey study was conducted to middle school students in the fall of 1989. The whole population of students who were enrolled in a middle school in the school district were surveyed. There were a total number of 306 respondents,142 of which were male and 164 of which were females.

The survey developed for the second study was modified for the third study (Appendix 4). The questions on students' enrollment in high school elective computer course were deleted. The following questions were added: whether students attended to a computer camp or club, whether students play home video games; how they felt about previous classes using computers, interaction with classmates and teachers, availability of computers at school, and the content of the software used in the courses; how their friends would react to them if they want to learn about computers; in which subject areas they used computers; and in which subject areas they wish to use computers.

The data concerning total time spent with computers and role models were analyzed on the basis of the T-test to examine any existence of differences between male and female students, and between students who are interested in taking a high school computer course and those who are not. The other data on students' attitudes, previous work with computers in a classroom, extracurricular activities, and future plans were analyzed based on the Mann-Whitney U test to determine any difference between males and females, and between students who want to take a high school computer course and those who do not.

Results

Differences were found on some factors between males and females and between the students who intend to take a high school computer course and those who do not within each gender group (Appendix 3). Also, students' anectdotal answers to some open-ended questions are included in Appendix 5.

A comparison between males and females was made on their attitude toward computers, hours of computer use, extracurricular activities, future plans, role models, perception of difficulty and importance of computer use, previous experience in using computers in a classroom, and subject areas in which they used computers or in which they wish to use computers. In addition, a further comparison was made between males and females by distinguishing the group of students that showed interest in taking a high school computer course from the other group that did not show such interest. Overall, gender related differences were more apparent among students with intent to take a high school computer course than among those without such intent. When the comparison was extended to distinguish grade levels, in some cases increases in gender differences were

found in a higher grade level.

In attitude toward computers, males showed more self-confidence in computer use, and more gender stereotyped views about computer use than females (Table 1). More significant differences between gender were found when the gender related comparison was made among those who intent to take a high school computer course. Among such students, males showed significantly more positive attitude toward computers, self-confidence and general utilities of computers than females. They also demonstrated more gender stereotyped views than females. Differences between males and females in self-confidence, general attitude, computer utility and sex bias all become significant by the 8th grade. Among the students who do not show intent to take a high school computer course, gender differences were found only on sex bias; males showed more biased opinions about gender in computer use than females. The increase of gender differences was not shown in the group of students who do not intend to take a high school computer course.

Hours of computer use also differentiates males and females. Males reported significantly more computer use in terms of the amount of time than females, especially at home and at school.

No significant differences were found between gender in terms of their participation in a summer computer camp or a after-school computer club, and their use of a home video game. However, among those who intend to take a high school computer course, males reported significantly more use of home video games than females.

No significant differences were identified between males and females in their plans to take a computer course in or after high school, a major in college and a computer-related job as their career.

Male students had a significantly larger number of male role models and females had a significantly larger number of female role models (Tables 2-3

and Graph 1). This was most often the case with friends but also was evident with parents and siblings at home. work and school. Among those with intent to take a high school computer course, very similar results were found. Gender related differences were less apparent among the students who do not show the intent than among those with intent.

The difficulty and importance of computer use proved viewed similarly by all respondents. No significant difference was found between females and females in their opinions on the difficulty and the importance of computer use. Students answered highly positive about the importance of computers and did not generally feel the computers were difficult to use.

Females thought that classmates were more helpful than males did, however, males felt that teachers were more helpful than females did. A significantly larger number of males wished to have more computers at school. The same results were found among students who show intent to take a high school computer course. Among those who do not show the intent, the significant difference was only apparent in the interaction with classmates; more female students thought that classmates were helpful in their previous classes using computers than male students.

More females named science as a class in which they used computers and more males named industrial arts as a class in which they used computers (Graph 2). The same results were found when male students were compared with female students, within the group of students who show interest in taking a high school computer class. Within the group of students who do not show such interest, the difference was found only for science: more females named science than males.

Overall, males wanted to use more computers in a variety of subject areas than females (Graph 3). Males named computer classes, social studies, industrial arts, art and music, library, home economics and gym significantly more often than females. Among those who intend to take a

high school computer class, additional significant differences were found in math and study hall; more males wished to use computers in those areas than females. The group of students who do not intend to take the course showed less significant differences than the other group. The number of subject areas in which students would like to use computers increased with age.

In addition to the comparison between gender, to extend the findings from the second study conducted in 1988, a comparison was made between those who intend to take a high school computer course and those who do not among males and among females. The comparison was made on their attitude toward computers, hours of computer use, extracurricular activities, future plans, role models, perception of difficulty and importance of computer use, previous experience in using computers in a classroom, and subject areas in which they used computers or in which they wish to use computers.

Both for males and females, the students who plan to take a high school computer course demonstrated more positive opinions about self-confidence, general attitude toward computers and utility of computers than the other students who do not plan (Table 1). Also, both for males and females, the former group showed significantly less biased views about gender in computer use than the latter group. The differences were almost equally shown across grade levels.

Concerning the hours of computer use, the male students who intend to take a high school computer course reported significantly more use of computers in terms of the amount of time than those who do not intend. No significant difference was found for females or males who do not intend to take a high school computer course.

Information on students' extracurricular activities showed that the students who plan to take a high school computer course had attended an

after-school computer club more than those who do not, both for males and for females.

When students were asked about their plans for future, for males, the students who intend to take a high school computer course had more plans to take a computer course after high school and to have a computer-related job than those who do not. For females, no significant difference was found.

The students who intend to take a high school computer course reported significantly more often than those who do not for certain role models (Tables 2-3 and Graph 1). In general, significant differences were found more for males than for females. For males and especially for females, more significant differences were found at school than at home or workplace.

For both males and females, the students with intent to take a high school computer course thought about the importance of knowledge on computer use more positively than the others. For females, the students with intent reported computer learning as easy more often than those without intent.

For both males and females, the students who intend to take a high school computer course liked their previous computer classes and wished to have more computers at school more often than those who do not intent to take one. Only among males, those with intent reported more positive opinions about the interaction with classmates in their previous computer using classes than the others.

Among females, the students who show interest in taking a high school computer course reported more use of computers in language arts than the others. Among males, the students with intent reported more use of computers in industrial arts than the others. In all other subject area, no significant difference was found.

Overall when students were asked to name the classes in which they wish to use computers, significant differences were found between the

students who show intent to take a high school computer course and those who do not more for males than for females; males showed more interest in using computers in a variety of subject areas than females.

Among females, those with intent named science, language arts, and foreign language more often than those without intent. Among males, the students with intent named math, science, computer science, language arts, industrial arts, study hall, home economics, gym and foreign language more often than the others.

Discussion

The third study examined differences between males and females all respondents as well as with several subcatagories. This proved to be helpful in establishing a general impression of male/female differences. The more detailed investigation of differences based on grade level and intent to take a high school course were valuable in establishing a better picture of specific differences. It is through this combination of general and more specific criteria for analysis that a more consistent pattern of behavior becomes clear.

Differences between males and females overall were examined to determine if general gender differences in respondents could be established. Issues in gender differences were then subdivided into four major areas, differences between males and females who intend and those who do not intend to take a high school computer course and differences within the male and female respondents based upon intent to take a computer course in high school. A number of significant differences were established as well as areas that appear not to be significant but are sometimes cited as possible areas of investigation.

It appears that between males and females, there are several clusters of differences. Males generally have more experiences with computers in and out of school. This is reflected in a greater number of male role models when compared to females. It could also be said that male students are more likely to have a male friend who is a computer user. Females more often indicated that they have a female friend who uses computers than male students. The male/female difference may be a result of clustering of students in the middle grades on the basis of gender.

We find differences exist when looking at specific subject areas in which computers are reportedly used that conform to general expectations. More males reported the use of computers in industrial arts while more females reported the use of computers in science. This indicates that females associate computer use more closely with science, a subject area found to by low in female participation, while males reported computer use in the traditionally male dominated area of industrial arts. Males were more interested in using computers in a wide variety of subject areas than females. More of the males respondents would typically answer that computers should be used in all subjects, while female were generally more indecisive about the computer use in subject areas. This indicates a strong gender difference on the part of males in their desire to use computers within school.

The attitude scales picked up a difference in male/female feeling of self confidence with computer and gender bias about computers. Males indicated a higher overall level of confidence with computers than did females. This is consistent with the finding that males are more interested in widespread use of computers in the classroom. Males also indicate that they feel that computers are part of their world. The sex bias scale shows that males feel that they are more likely to be better at using computers than females.

When looking at differences within grade levels, more significant gender differences were found as the age of the respondents increased. Almost no significant differences in the courses that students would like to use computers appeared in the 6th or 7th grades, while significant differences were found in the 8th grade. This was also true for self confidence, utility and general attitude toward computers. It appears that younger students do not differentiate computer use along gender lines with students in the 8th grade starting to exhibit those gender differences.

The comparison of males and females when grouped by intent to take a high school computer course indicates that gender differences generally appear among those who intend to take a high school course, and not those who don't. Those who intend to take a high school computer course exhibit gender difference patterns similar to those of the entire population. Males generally express a greater interest in computers and a more favorable attitude toward computers than females. However, respondents who do not intend to take a high school computer course do not exhibit these gender differences. Males and females who are not interested in computer courses in high school show very little difference in using computer in other subjects, have similar views of computer utility and self confidence with computers. Only in sex bias, did a significant attitude difference appear with males expressing more sex bias than females.

Within each gender group, when a more detailed look at the difference between the students who intend to take a course and those who don't, the results were similar to those found overall. The students who intend to take a high school computer course reported more positive opinions about the interaction with classmates in their previous classes using computers. Considering that males and females who intend to take a computer course in high school had more friend role models at school than those who do not, the latter group's negative experience with classmates in computer-using

classes seems to be an importance factor affecting their interest in computer courses.

Both males and females, those with interest in taking a computer course demonstrated more positive attitude toward computer learning, utility of computers and self-confidence, and more sex bias toward gender in computer use than those without such interest. Having positive attitudes toward computers may help students get interest in computer learning. This positive attitude may also be a factor in actual performance, with students who have positive attitudes being more inclined to be successful at computer use. It may be important in a subsequent study to attempt to determine if, in fact, a relationship does exist between performance and interest and if that relationship is gender related.

Mostly among males, the group of students who intend to take a high school computer course tended to have interest in using computers in a variety of subject areas, computer experiences, role models, and computer-related future plans more often than the others. Those respondents who intended to take another course also demonstrated a positive feeling about the utility of computers. It may be useful to take a further look for the existence of a relationship between this feeling of general usefulness and use within subject areas in addition to the differences explored in this study.

Positive experience in previous computer using classes, a large number of role models, and the frequency of computer use and learning may affect students interest in computers, attitude toward computers and future plans as does the comparison between those who intend to take a computer course and those who do not indicate. But, this causal relationship was not the purpose of this study.

CONCLUSION

Throughout this series of three studies, some consistent results were found. Gender differences exist in high school computer science courses. These differences are more apparent in advanced courses than in beginning courses. A survey of computer science instructors confirms that this differences continues with a similar ratio of males to females within computer classes to that which formed the basis for the first study's statistical analysis. The increased use of computers in elementary and middle grades over the last several years doesn't seem to have a marked effect on gender differences in the population within this school district.

Respondents who have taken or who intend to take a high school computer science course have a more positive general attitude toward computers. This link between attitude and desire to take a course may be a way in which females could be influenced. Positive experiences with computers should be established in order to foster an interest in continuing with computer education. The perceived usefulness of computers also was significantly higher for those respondents who intend to continue with computers, whether they were males or females. The third consistent finding in this area was the respondents' self confidence with computers. Those who indicated a desire to take additional computer courses were also more confident about using computers. These differences were found within males and females as well as between males and females. It appears then, that females who do not wish to continue computer education share some of the same characteristics as males who do not wish to continue with computer education in the attitudes and confidence.

Sex bias between males and females also exhibited a consistent pattern. Males were more biased in their view of computers as a male domain than were females. Females in general expressed a feeling that there were no differences in the ability of females to be successful in learning about or

using computers. This is in sharp contrast to the generally lower level of self confidence expresses on that subscale. It appears that the generalized concept of female in relation to computers is different than their perception of personal success. This difference between the generalized female and personal perception should be explored further in order to attempt to reconcile the discrepancy between self-reported beliefs and actions.

Perceived differences between male and female computer use found in the first and second is another area of reality conflicting with belief. Females and males both show an increase in sex bias in advanced computer courses. The open ended responses about gender differences give an enlightening clue about the difference. Males and females consistently cited the lack of females in beginning and intermediate courses as a reason to believe that computers were more for males than for females. This perception was absent from the third study, probably because in the middle grades, most computer courses and activities are required for both males and females.

Role models are also a factor in computer course selection. Females who have participated in computer courses as well as those who express interest in taking a computer course have a larger number of female role models than those who don't desire to take another course. This difference is more consistent at school than at home or in the work place although some differences in both those areas appeared in the series of studies. Males in general had a larger number of male role models than females had female role models. Males who intend to take a high school computer course also show more role models in the third study. This seems to indicate that role models may be related to participation in computer courses. Student who have close associations with other computer users are more likely to want to take a computer course than those who don't have as large a number of role models.

Game playing and hours of computer use, two other areas of commonly cited as areas of differences, did not appear consistent between males and females. The students in the third study did not show any significant difference in video game playing at home. This is probably because nearly all of the students, both male and female, indicated that they play video games. Home computer use also shows a similar result because of the opposite, not many students used a computer at home. It could be that recreational use of computers at home has been supplanted by video games so that productivity software is the primary type present in homes. There would not be the same gender related differences with home computer use as earlier reports of computers used for game playing.

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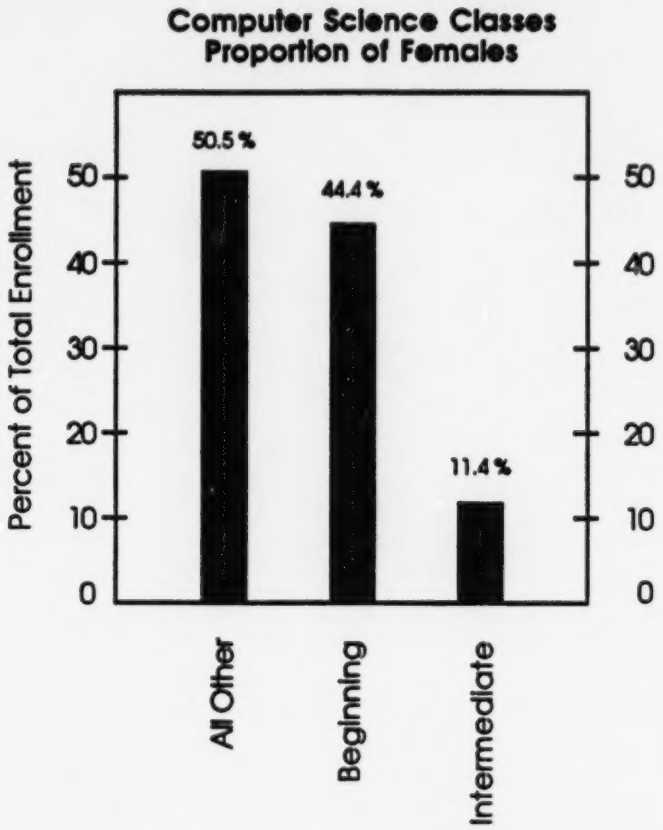
APPENDIX 1

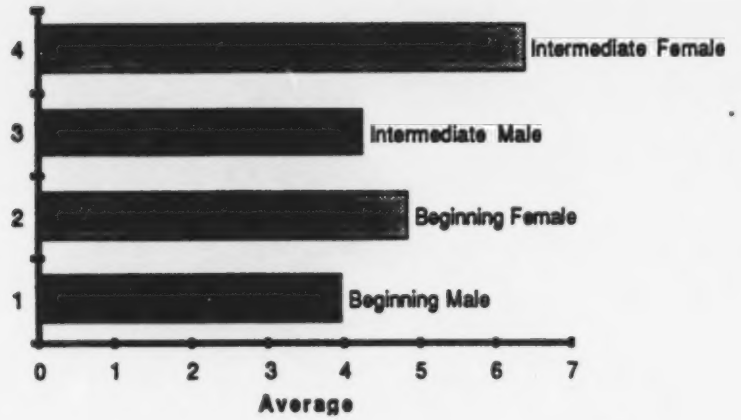


Fall Semester 1987 Enrollment

The percent proportions given are for all computer science classes conducted in the Fall semester of 1987 for four Madison Metropolitan School District High Schools. The "All Other" catagory represents the proportion of females that are not emrolled in computer science courses.

GRAPH/TABLE 2

All Role Models Combined

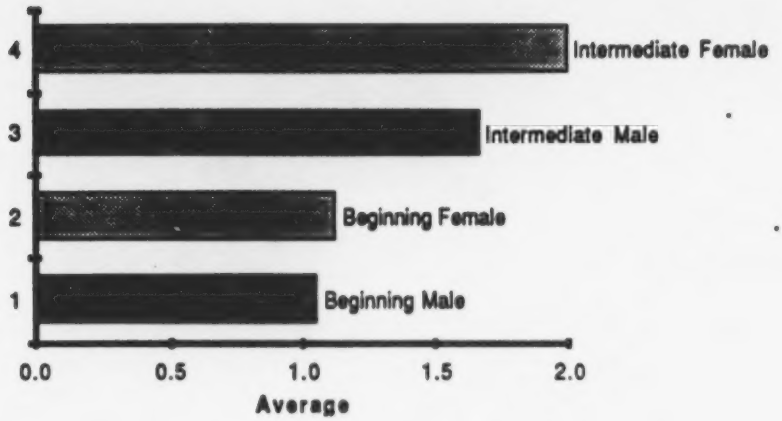


The average number of role models given for home, work and school regardless of role model gender. The averages of role models are given by level of class and gender.

Group	N	Mean	SD
Beginning Male	68	3.96	1.92
Beginning Female	57	4.84	2.40
Intermediate Male	36	4.25	1.57
Intermediate Female	5	6.40	2.30

GRAPH/TABLE 3

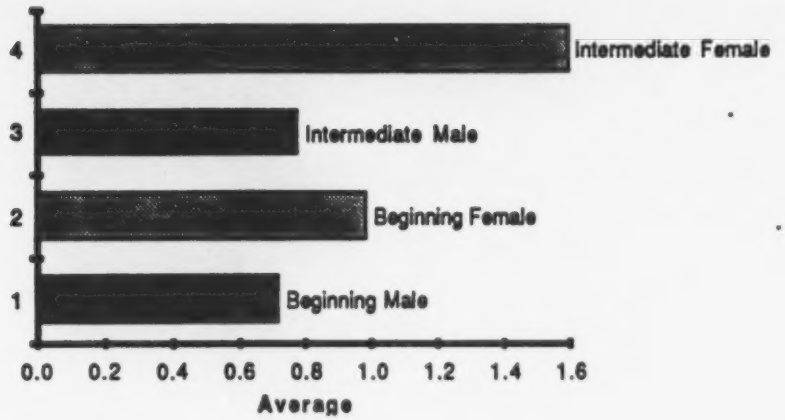
Male Role Models



The average number of role models who are males for home, work and school. The averages of role models are given by level of class and gender.

Group	N	Mean	SD
Beginning Male	68	1.06	1.02
Beginning Female	57	1.12	1.18
Intermediate Male	36	1.17	.97
Intermediate Female	5	2.00	1.00

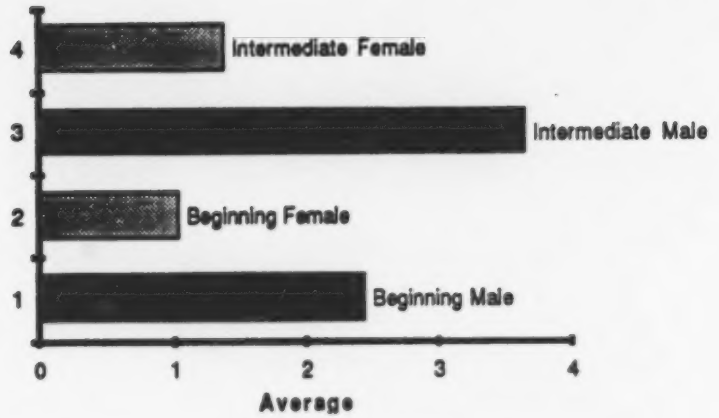
Female Role Models



The average number of role models who are females for home, work and school. The averages of role models are given by level of class and gender.

Group	N	Mean	SD
Beginning Male	68	.72	.75
Beginning Female	57	.98	1.09
Intermediate Male	36	.78	.72
Intermediate Female	5	1.60	1.14

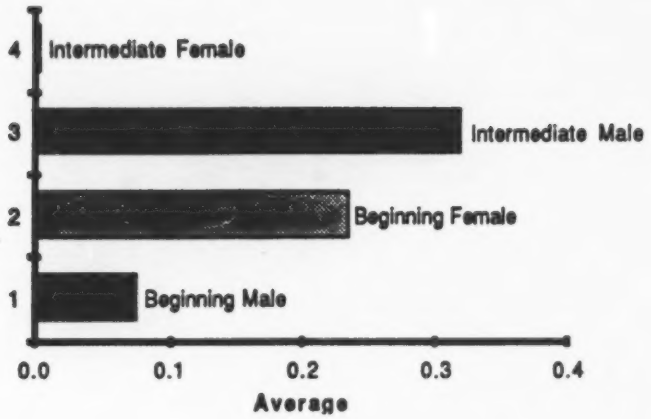
Sex Bias



The average total response to three questions on the ability of males and females to do equally well in working with computers. The averages of sex bias are given by level of class and gender.

Group	N	Mean	SD
Beginning Male	68	2.44	2.50
Beginning Female	57	1.05	1.85
Intermediate Male	36	3.67	2.35
Intermediate Female	5	1.40	2.07

Perceived Difference



The average of the perception that there is no difference between males and females in computer use. A score of 0 indicates that there is no difference and a 1 indicates that there is a difference. The averages of perceived differences are given by level of class and gender.

Group	N	Mean	SD
Beginning Male	52	.08	.27
Beginning Female	52	.06	.24
Intermediate Male	28	.32	.48
Intermediate Female	3	.00	.00

APPENDIX 2

TABLE 1

Role Models

T-test for the comparison of the number of role models between students who have taken a computer course and those who have not, and between those who intend to take a(another) computer course and those who do not intend to take a computer course in high school.

	Taken		Intended	
	Male	Female	Male	Female
WPM				
WPF				
WB	.0205			
WS				
WFrM				
WFrF				
HPM	.0344			
HPF				
HB				.0801
HS				
HFrM	.0052		.0942	
HFrF				
ScTM	.0000	.0005		.0231
ScTF	.0576			
SccB				.0801
ScS	.0191			
ScFrM	.0000	.0776		.0696
ScFrF	.0000	.0206		.0048

W - work	H - home	Sc - school
P - parent	B - brother	S - sister
Fr - friend	M - male	F - female

Note: For the purpose of discussion, results that have value of $p < .1000$ is considered significant and indicated by bold type. These data may be useful for determining further directions for investigation.

TABLE 2

After High School Plans

Mann-Whitney U test for the comparison of post high school participation in computer related activities.

	Taken		Intended	
	Male	Female	Male	Female
After high school course	.0000	.0180	.0545	.0128
Computer science major			.0134	.0730
Computer job	.0001	.0010	.0001	.0007

Note: For the purpose of discussion, results that have value of $p < .1000$ is considered significant.

TABLE 3

Attitudes

Mann-Whitney U test for the comparison of student attitudes in relation to gender bias, utility of computers, general attitude toward computers and self confidence in the use of computers.

	Taken		Intended	
	Male	Female	Male	Female
Sex bias	.0635		.0445	
Utility	.0004	.0001	.0000	.0001
General attitude	.0000	.0001	.0004	.0034
Self confidence	.0000	.0002	.0000	.0002

Note: For the purpose of discussion, results that have a value of $p < .1000$ is considered significant.

TABLE 4

Class Experience

Mann-Whitney U test for the comparison of students' experiences in previous computer science courses between those students who have indicated they would take another computer class and those who have not.

	Mann-Whitney	
	Male	Female
Liked class		.0583
Helpfulness of peers		
Availability of teachers		

TABLE 5

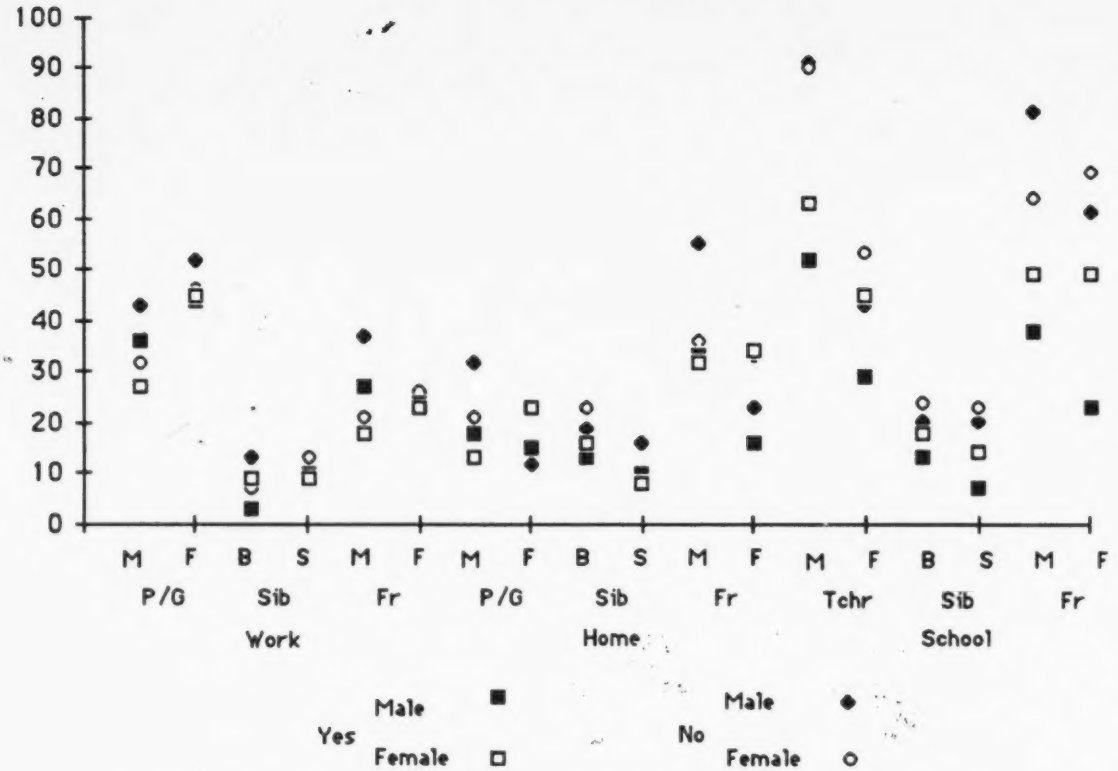
Hours of Computer Use

T-tests for the comparison of hours of computer use in relation to participation in computer courses and intent to participate in a computer course.

	Taken		Intended	
	Male	Female	Male	Female
T-test	.0001	.0000	.0568	

GRAPH 1

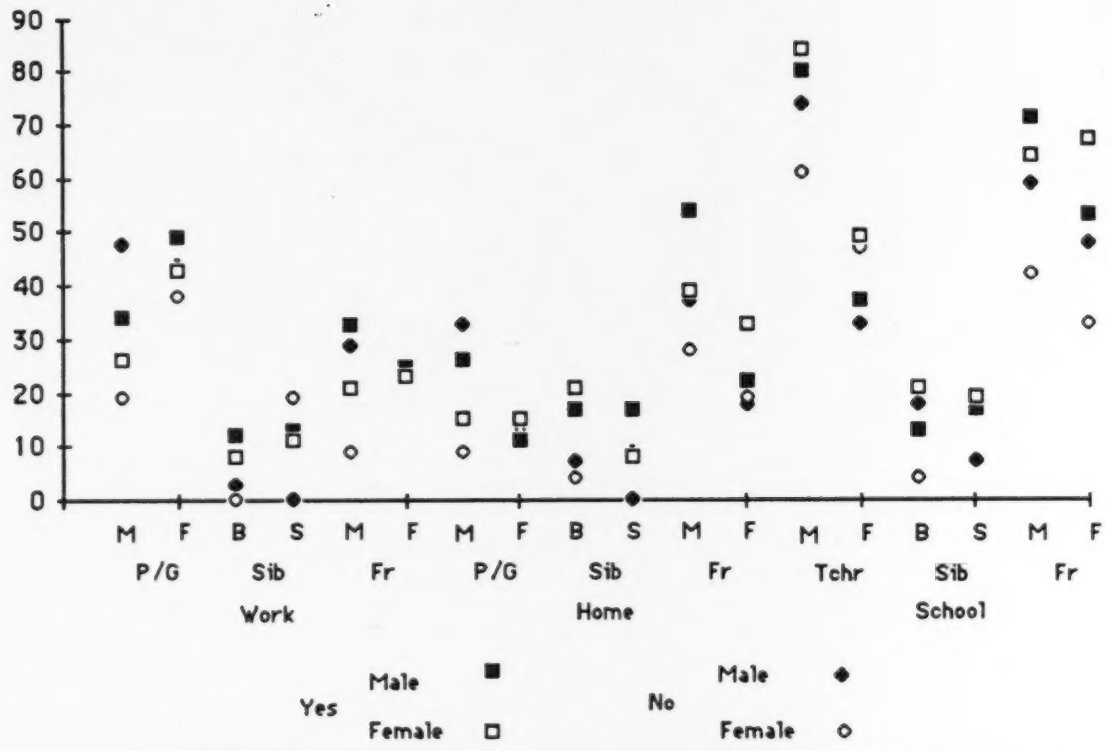
Role Models
Course Participation



Percentage of role models reported by respondents differentiated by participation in a computer science course.

GRAPH 2

Role Models
Course Intent



Percentage of role models reported by respondents differentiated by intent to take another computer science course.

APPENDIX 3

TABLE 1

General Attitudes Toward Computers

Gender Difference Overall

	all	6th	7th	8th
Self Confidence	0.0477			0.0137
Utility	0.0814			0.0856
General Attitude				0.0301
Sex Bias	0.0000	0.0509	0.0006	0.0226

Gender Difference within Intent

	all	6th	7th	8th
Self Confidence	0.0172			0.0106
Utility	0.0269	0.0677		0.0486
General Attitude	0.0445			0.0049
Sex Bias	0.0001	0.0454	0.0009	0.0465

Gender Difference within Non-intent

	all	6th	7th	8th
Self Confidence				
Utility				
General Attitude				
Sex Bias	0.0290		0.0530	

Intent Difference within Females

	all	6th	7th	8th
Self Confidence	0.0004	0.0622	0.0047	
Utility	0.0001		0.0004	0.0175
General Attitude	0.0002	0.0410	0.0015	0.0579
Sex Bias	0.0148	0.0365		

Intent Difference within Males

	all	6th	7th	8th
Self Confidence	0.0000	0.0481	0.0002	0.0101
Utility	0.0000	0.0079	0.0008	0.0017
General Attitude	0.0000	0.0045	0.0003	0.0001
Sex Bias	0.0741			0.0426

TABLE 2

Role Models

Role models at work, home and school. The p-value for a t-test of the statistical significance between males and females for all respondents, between males and females who intend and those who do not intend to take a computer course in high school, and between those who intend and those who do not intend to take a computer course in high school within gender. P-values for nonsignificant cells are left blank.

	Intend Male/Female	Non-intend Male/Female	Male Intend/Non	Female Intend/Non	All Male/Female
WPM			.0959		
WPF		.0108			.0217
WB					
WS					
WFrM	.0090				.0256
WFrF	.0982	.0553			.0221
HPM	.0190				.0923
HPF					
HB	.0871		.0113		
HS					
HFrM	.0046	.0108			.0004
HFrF	.0000	.0009			.0000
ScTM		.0300	.0043		
ScTF					
SccB	.0284		.0707		.0479
ScS	.0322			.0525	
ScFrM	.0008		.0246		.0013
ScFrF	.0001			.0176	.0001

W - work
P - parent
Fr - friend

H - home
B - brother
M - male

Sc - school
S - sister
F - female

TABLE 3

Role Models

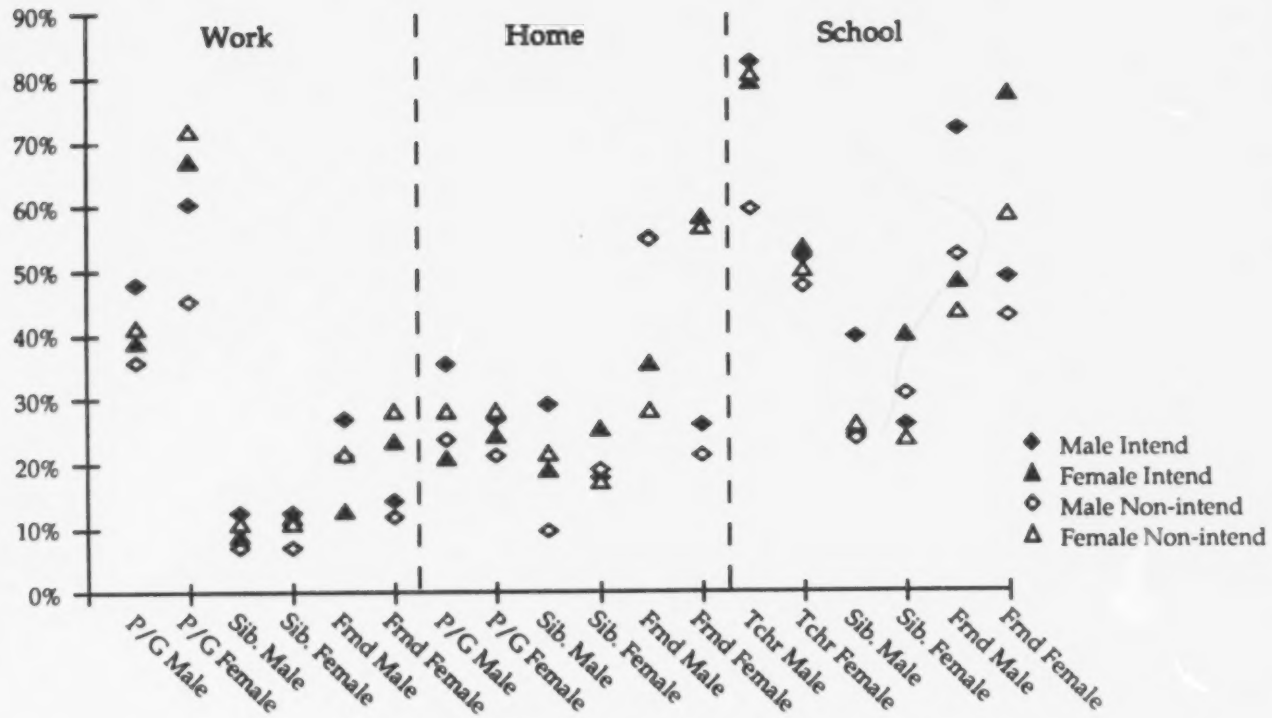
Proportion of role models at work, home and school listed for all respondents, those intended to take a computer course in high school, those who do not intend to take a computer course in high school differentiated by gender.

	Intend		Non-intend		All	
	Male	Female	Male	Female	Male	Female
Work						
P M	48%	39%	36%	41%	44%	39%
P F	60%	67%	45%	72%	56%	68%
B	13%	9%	7%	11%	10%	9%
S	13%	12%	7%	11%	10%	12%
Fr M	27%	13%	21%	22%	25%	15%
Fr F	15%	24%	12%	28%	14%	24%
Home						
P M	35%	21%	24%	28%	30%	22%
P F	27%	25%	21%	28%	25%	25%
B	29%	19%	10%	22%	25%	20%
S	18%	25%	19%	17%	19%	25%
Fr M	55%	35%	55%	28%	55%	34%
Fr F	26%	58%	21%	57%	25%	58%
School						
T M	82%	79%	60%	80%	76%	80%
T F	52%	54%	48%	50%	51%	53%
B	40%	25%	24%	26%	36%	26%
S	26%	40%	31%	24%	28%	35%
Fr M	72%	48%	52%	43%	67%	48%
Fr F	49%	77%	43%	59%	48%	72%

P - parent/guardian
B - brother
M - male
T - Teacher
S - sister
F - female
Fr - friend

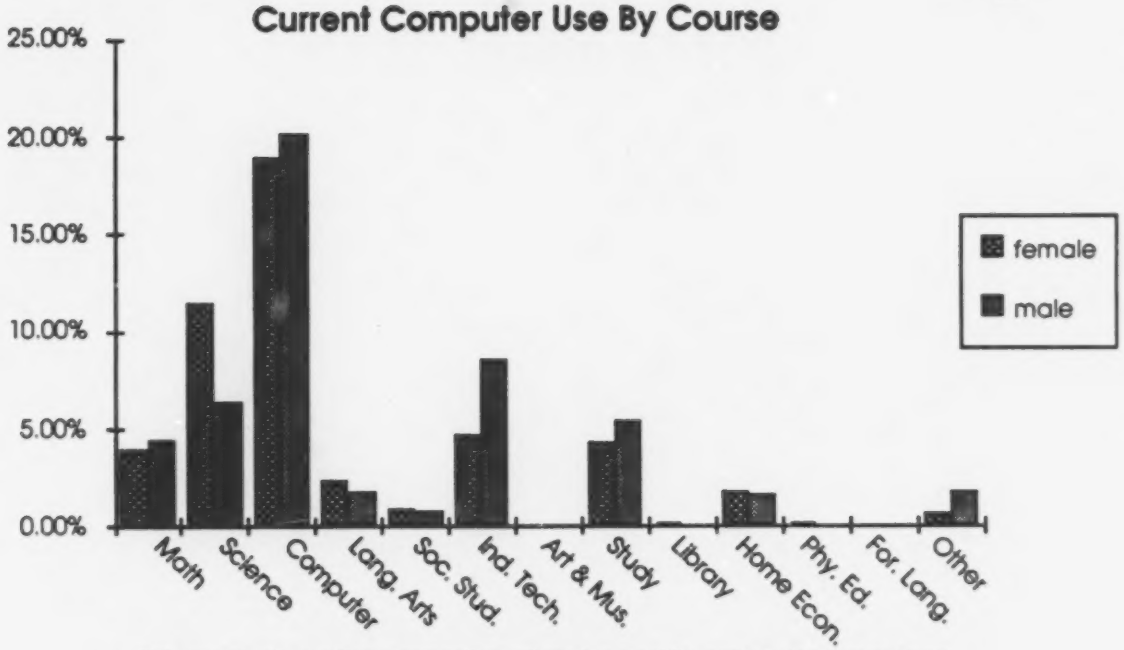
GRAPH 1

Role Models



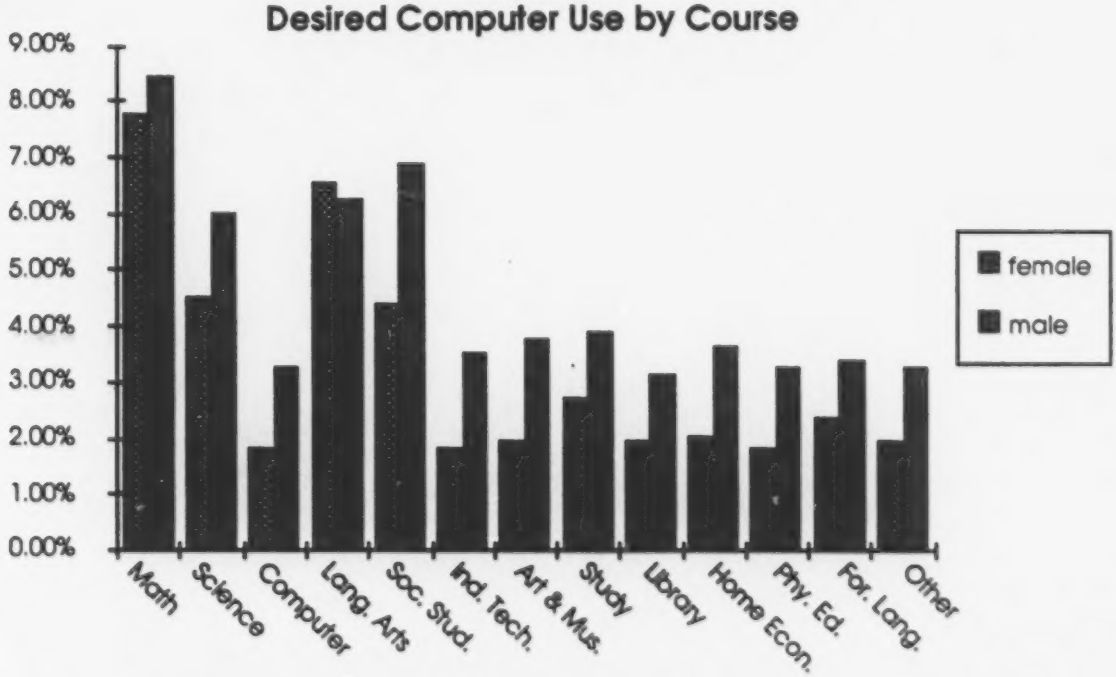
This graph shows the percent of role models of the respondents by gender and intent to take a computer course in high school.

GRAPH 2



This graph shows the proportion of males and females who have used computers in the given classes. Percents are in relation to the total number of course reported by all respondents.

GRAPH 3



This graph shows the proportion of males and females who would like to have computers in the given classes. Percents are in relation to the total number of course requests by all respondents.

APPENDIX 4

Computer Survey

Circle the letters that most closely match how you feel about each statement.

SD - Strongly Disagree D - Disagree NO - No Opinion A - Agree SA - Strongly Agree

1.	I would like to own my own computer.	SD	D	NO	A	SA
2.	Working with a computer makes me want to learn.	SD	D	NO	A	SA
3.	I learn a lot with a computer.	SD	D	NO	A	SA
4.	Being able to work with a computer is important.	SD	D	NO	A	SA
5.	I like to use a computer.	SD	D	NO	A	SA
6.	I like using computers in school.	SD	D	NO	A	SA
7.	I enjoy making a computer do what I want.	SD	D	NO	A	SA
8.	I don't like working on a computer.	SD	D	NO	A	SA
9.	Computers are a tool just like a hammer or saw.	SD	D	NO	A	SA
10.	Using a computer is a waste of time.	SD	D	NO	A	SA
11.	Using computers is more for boys than for girls.	SD	D	NO	A	SA
12.	People don't need computers.	SD	D	NO	A	SA
13.	I enjoy using the computer.	SD	D	NO	A	SA
14.	Computers are more for boys than girls.	SD	D	NO	A	SA
15.	I am good at running a computer.	SD	D	NO	A	SA
16.	Girls do just as well as boys in computer jobs.	SD	D	NO	A	SA
17.	I don't work well with computers.	SD	D	NO	A	SA

Computer Survey

Page 2

Please circle: Grade 6 7 8

Age 10 11 12 13 14

Sex Male Female

Estimate the average number of hours per week that you currently use a computer at:

Home ____ School ____ Work ____ Other ____ Where?

Answer the following set of questions on your previous work with computers in a classroom:

I liked my previous computer classes. yes no

Classmates were helpful when I needed help. yes no

My computer teacher was usually available when I needed help. yes no

I wish the school had more computers so that I could use a computer alone. yes no

Most software used in class is a contest against the computer or another person. yes no

My friends would think I am _____ if I wanted to learn about computers.

I <u>have used</u> computer in these classes.

_____

_____

_____

I <u>wish I could use</u> computers in these classes.

_____

_____

_____

Computer Survey

Page 3

I have attended a summer computer camp.	yes	no
I have attended an after-school computer club.	yes	no
I play home video games (nintendo, atari, etc.).	yes	no

Would you take a computer course in high school?	yes	no
After high school, would you like to take a computer course?	yes	no
Would you like to major in computer science in college?	yes	no
Would you like a job working with computers?	yes	no

Check the people that you know who use computers at work, home or school:

	Parent/Guardian				Friends	
	Male	Female	Brother	Sister	Male	Female
Work	____	____	____	____	____	____
Home	____	____	____	____	____	____

	Teachers				Friends	
	Male	Female	Brother	Sister	Male	Female
School	____	____	____	____	____	___

Computer Survey Page 4

Please give your thoughts about the following statements:

Some people think that there is a difference between males and females in how they feel about computers.

Some people think that it is difficult to learn to use the computer.

Some people think that it is becoming increasingly important to know how to use the computer.

Thanks for your cooperation in answering the questions on this survey. Please make any additional comments concerning computer courses that you would like.

APPENDIX 5

1 : female

Why haven't you taken a high school computer course?

"I don't understand them and I am afraid to flunk.Computers are for smart people."

Would you take a computer course in high school if possible?

"Yes, if I thought the teacher could teach it to me."

Make any additional comments concerning computer courses.

"I'd like to learn. It is not like I hate them. I would not mind sitting behind a computer for 8 hours a day. I hope I will understand them more someday."

2 : female

Why haven't you taken a high school computer course?

"Because I don't like computers. They are confusing and smarter than I am, and I don't understand how to use them."

Give your thoughts about: some people think that it is difficult to learn to use computers.

"Yes, it is. The computer is smarter than you and it makes you feel stupid when you did not do something right."

3 : female

Give your thought about: some people think that it is becoming increasingly important to know how to use the computer.

"It is and that is not good because they will over run the world."

4 : male

Make any additional comments concerning computer courses.

"Courses should be less lecture and more hands on type work. Lectures could be given in the lab so the students can see how the work is applied first hand."

5: male

Make any additional comments concerning computer courses.

"I'd take some more classes if they were available."

6: female

Why haven't you taken a high school computer course?

"Because I don't have a computer at home. I don't have any use to yet."

7: male

Give your thought about: some people think that it is difficult to learn to use the computer.

"Yes, it is, if you don't have a good teacher."

8: female

Make any additional comments concerning computer courses.

"There should be a class just for typing like on an every other day basic for only like a half hour schedule.Because I don't want a computer major, I want to know how to type."

9: female

Why haven't you taken a high school computer course?

"I don't like working with computers and it is too much like typing."

Give your thought about: some people think that there is a difference between males and females in how they feel about computers.

"It seems like guys think that using a computer is uncool, but girls are a little more open-minded."

10: female

Why haven't you taken a high school computer course?

"Because there are other important classes that I need to take."

11 : female
Give your thought about: some people think that it is becoming increasingly important to know how to use the computer.
"For people who are not willing to learn, that can be difficult. Otherwise it is very easy to learn."

12 : female
Give your thought about: some people think that there is a difference between males and females in how they feel about computers.
"Maybe because a guy might love video games. A girl may love to type."

13 : male
Give your thought about: some people think that it is difficult to learn to use the computer.
"I know it's easy because I, well my family owns four computers."

14 : female
Give your thought about: some people think that it is difficult to learn to use the computer.
"True. I find it hard. In a class with only one instructor (especially one with a negative attitude), it is hard to get help and understanding you need."

15 : female
Give your thought about: some people think that there is a difference between males and females in how they feel about computers.
"Ridiculous. To think that one sex is better at computers than the other is an example of how society still carries around silly stereotypes."

16 : female

Give your thought about: some people think that it is becoming increasingly important to know how to use the computer.
"True. This is the 90's, a decade of technology. No matter what your job is. To go without this skill now and in the future is foolish."

17 : female
Give your thought about: some people think that it is becoming increasingly important to know how to use the computer.
"It makes work go easier and faster than without one."

18 : female
Give your thought about: some people think that there is a difference between males and females in how they feel about computers.
"Yes. I think it's because on TV, you always see the nerd (boys usually) with taped glasses and always on their way to the computer room."

19 : male
Perception of friends' reactions to learning about computers.
"My friends would think I am nuts if I wanted to learn about computers."

20 : male
Perception of friends' reactions to learning about computers.
"My friends would think I am freak if I wanted to learn about computers."

21 : female
Give your thoughts about: some people think that it is becoming increasingly important to know how to use the computer.
"I think so, too. Computers are fun and interesting.While you are having fun, you can learn, too."

22 : female

Give your thoughts about: some people think that there is a difference between males and females in how they feel about computers.

"I don't. I think people are equally intelligent in their own way."